A GIS-BASED INDEX TOOL FOR THE SELECTION OF PONDS FOR FISHERIES

Chitra Khanna

In Central India, a GIS-based geo-hydrological composite index tool has been developed to enable the selection of suitable perennial ponds for fisheries. The tool also allows users to take a comprehensive view of a district and make decisions for natural resource management interventions.

Fisheries and aquaculture provide livelihoods for millions of people across the world. In 2014, production from inland water capture fisheries was 160 million tonnes globally, and constituted 12.74% of total capture production. India is the third largest producer of inland fish, and the second largest producer of farmed fish. In India, nearly 65% of total fish production (presently at around 10 million t) comes from the inland sector.

Madhya Pradesh is situated in the central region of India, and has a total river length of 17,000 km, and almost 4 million hectares of water area in reservoirs. Of the available reservoir area, 98% has been brought under fisheries, including 0.64 million hectares of rural ponds. Socially, fisheries have been the traditional occupation of persons belonging to scheduled caste groups such as the Bhoi, Dheemar, Kahar, Kevat, Mallah, Nishad and Raikwar. These groups live across different districts of Madhya Pradesh and are skilled in deep water fisheries.

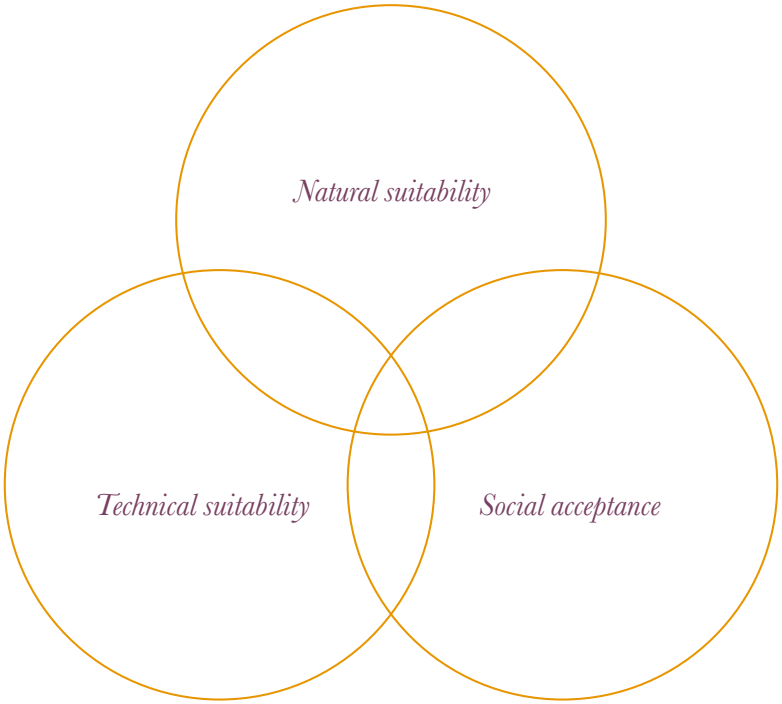
Tribal fishers have traditionally conducted capture fisheries, hunting fish by using bows and arrows, laying down fish traps and casting nets. The fisheries of tribal fishers were mostly in shallow waters and were developed for self-consumption. However, with the support of the government, these fishers have been organised and trained in aquaculture-related practices. This has led to the development of deeper pond fisheries by the tribal community. Both scheduled caste and scheduled tribal communities practice fishing, but if an area is classified as 'schedule 5', it comes under the Panchayat Extension to Scheduled Areas Act, under which the tribes have first right to the resources.

In Madhya Pradesh, the selection of ponds for fisheries is not by design, but is incidental to their existence. At present, the rural ponds for fisheries are selected on the basis of their ability to retain water for different periods of time, and are classified as seasonal or perennial ponds by the Fisheries Department of the government. Once a pond is selected by the local governing body, it is leased out to either cooperatives, self-help groups (community groups that function to address social issues or improve livelihood activities) or fisher groups.

Cover A total of 65% of the fish production in India comes from the inland sector

The intervention

Supported by the United Nations Adaptation Fund Board and the National Bank for Agriculture and Rural Development, TAAL is implementing the project called *Building Adaptive Capacities of Small Inland Fishermen Community for Climate Resilience and Livelihoods Security in Madhya Pradesh*. The aim of this project is to select ponds that are naturally and technically suitable, as well as socially accepted to be utilised as fisheries, through the following steps:



Right The Girala pond

1. A natural suitability analysis through the development of a GIS-based composite index tool for hydro-geological assessment (described in the subsequent sections);
2. A technical suitability analysis via visits to the pond sites and ground-truthing; and
3. Social acceptance analyses of the local community to work at the fisheries via two separate social assessments.

The three districts comprising the project area, Alirajpur, Dhar and Jhabua, are predominantly rural in composition, with more than 80% of the population residing in the countryside. The districts are mostly inhabited by persons belonging to scheduled tribes, with the Bhils and Bhilalas as the major tribal groups.

There, ponds under 10 hectares were chosen as they fall under the jurisdiction of the *Gram Panchayat* – the village governing body which is the smallest unit of local governance in India. The ponds selected were modified to increase their water retention capacity and to reduce the incoming silt load, i.e. the inlets and outlets were repaired. Structures were also built to aid fish diversity and fish handling, such as a fish pass which prevents the outflow of fish through the waste weir, and a fisherman's platform to place equipment or the fish catch.

Based on the vulnerability assessment in the State Action Plan for Climate Change, TAAL developed a proposal for the Jhabua hills agro climatic zone. Parts of the Alirajpur, Dhar and Jhabua districts fall in this zone. Dhar has 1,474 villages, Jhabua has 818 villages and Alirajpur has 547 villages. A total of ten administrative blocks, covering 960 villages, were considered in the project proposal.

There was a need to develop a methodology that would enable an unbiased selection of the ponds most suitable for fisheries in the selected district blocks. A list of ponds was taken from the water resource department, the fisheries department and from the block level administration of the local government. The list ran into many pages and the challenge was to find the ponds that were both technically suitable as well as still physically existant.

The tool and the results

A hydro-geological assessment is a necessity before any pond is constructed. Since the project was working on existing ponds constructed by different government departments, it was safe to assume that the pond sites were naturally suitable for water impounding. However, it was important to establish that the pond sites were suitable for fisheries, and that the natural features had the potential to support the pond's perenniality – a desirable feature for fisheries.

Maps were sourced from the national government. These were scanned and updated using GPS technology to determine the coordinates of the most important geographical features. The maps were referenced to village boundaries, land use and existing water bodies. GIS was used for overlaying map information onto one document. Different meetings then took place between the hydro-geologists to decide the weight of importance of the technical parameters used to determine the hydro-geological suitability of the ponds. The different parameters taken for the assessment included the drainage density and the lithology. The most favourable condition for each

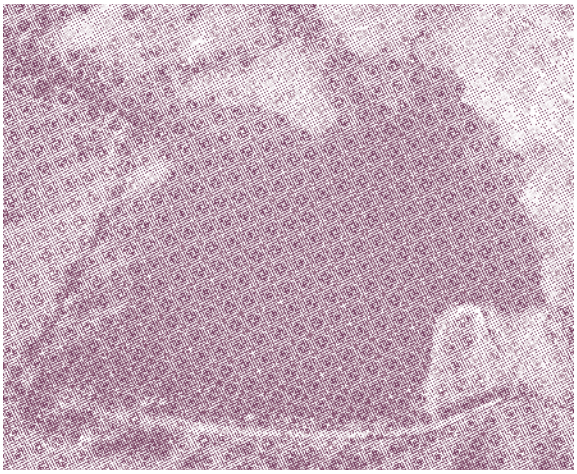


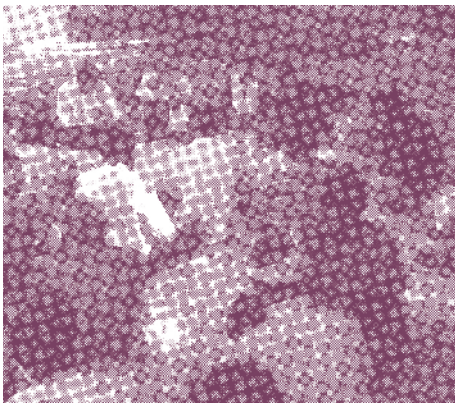
Table 1: *Weights given to soil parameters*

Soil Type	Clayey	Clayey calcareous	Clayey and loamy	Loamy calcareous	Loamy
	Valleys, plains and plateaus	Valleys, undulating plains, undulating and interveinal plateau, mound	Plateau and hill ranges	Plain land and undulating plains	Valleys, plateaus, hills, escarpments
Priority	1	2	3	4	5

Table 2: *Water body priority, Jhabua district*

Village name	Hira-khadan	Nawa-pada	Go-palpura	An-tarveliya	Khedi	Kalyan-pura	Parwat	Junwan-iya
Drainage density	2	1	2	1	2	2	1	1
Hydrology	2	3	3	3	3	3	3	3
Lithology	1	2	2	3	2	2	3	1
GeoMorphology	1	4	1	4	4	4	2	2
Land use	2	2	2	2	4	4	2	2
Pereniality	2	1	1	2	1	1	1	2
Slope	3	2	2	2	2	3	2	2
Soil	1	1	1	5	5	5	1	1
Area (ha)	7.385	0.609	1.606	5.982	2.655	1.398	6.628	11.513
Priority sum	14	16	14	22	23	24	15	14
Priority value	1.75	2.00	1.75	2.75	2.88	3.00	1.88	1.75
Priority	1	2	1	3	4	4	2	1

The tool provides a means of selecting perennial ponds for fishery activities from a list that may be based on anecdotal evidence.



Above An important step in the process was the identification of the technical parameters and the calculation of the priority rankings

parameter was given priority score of 1; the least favourable received a score of 5. Soil was one such parameter to be analysed and the priority score results for the various soil types are highlighted in the table. As an example, the next table shows the overall calculations for ponds in Jhabua district.

The GIS analysis and the thematic analysis of each of the technical parameters identified above provided the project an inventory of 429 suitable ponds from the 10 blocks. Out of these, 60 were selected for the project.

Selecting 60 ponds became easier once the priority rankings had been calculated. The hydro-geological composite index tool was also efficient in providing accurate GPS locations for each pond. This information was useful in identifying and locating potential ponds more rapidly, and as a result, the project visited more than 150 ponds in the first year. Eighty ponds out of the 150 were selected for ground truthing and technical assessment. The remaining ponds were not selected for ground thruthing due to reasons including high irrigation, serious damage to bunds, leakage/seepage, or also because of social issues.

The methodology and the results were presented to the technical advisory group made up of representatives of the Central Institute of Freshwater Aquaculture, the Central Institute of Agriculture Engineering, the Indian Institute of Soil Science, and the Water and Land Management Institute. Extensive discussions took place on the methodology of the exercise and this was approved by the group.

The exercise resulted in the development of the tool: GIS-based geo-hydrological composite index tool for selection of ponds for fisheries.

What can this tool do?

The tool provides a means of selecting perennial ponds for fishery activities from a list that may be based on anecdotal evidence. There was no strategic plan at the district level, and no priority list of ponds at the block or district levels. The tool developed allows the fisheries department to take a comprehensive view of the district and make decisions for different categories of ponds.

This tool can give:

a. Spatial locations of water bodies within a particular area;

b. The number of ponds in that particular area;

c. The water area of the ponds; and

d. The technical details for the different parameters of the entire geographical unit, including the drainage density, landforms, structural information, the geology, groundwater information, the soil, slope and the perenniality.

Table 3: *Inventory of ponds*

SN	District	Block	Number of ponds	Number of ponds less than 10 ha	Priority			
					1	**2**	**3**	**4**
1	**Dhar**	Manavar	53	31	0	1	17	13
		Gandhwani	43	28	0	2	12	11
		Bagh	38	30	0	0	19	9
		Kukshi	12	08	0	0	5	3
2	**Alirajpur**	Udaygarh	48	35	19	0	08	0
		Alirajpur	55	38	21	0	11	0
		Jobat	34	23	12	0	9	0
3	**Jhabua**	Jhabua	73	64	24	0	25	0
		Ranapur	113	103	55	0	32	0
		Rama	77	69	29	0	25	0
			546	**429**				

The tool has been accurate in terms of identifying the technical features of the site, but ground truthing, or the physical verification of the site, is still recommended to verify the present status and use of the resource. The tool saves time in identifying and shortlisting water bodies, and thus allows ground truthing in specific locations, saving time and costs. It can be replicated, but doing so will require:

a. A clear defined objective;

b. The acquirement of legal maps;

c. Licensed ARC GIS software;

d. Hydro-geology knowledge to update the geographical features using the software;

e. Knowledge of GPS to update GIS databases.

Maps have been made for the eight technical parameters and referenced to the present land use and village boundaries. Each of the maps can be used for multiple purposes. For example, the groundwater maps along with the drainage density maps can be used for planning water use, specifically drinking water in districts like Dhar, where the presence of fluoride in ground water is an issue.

This exercise is a robust planning tool for natural resource management interventions. It helped the project identify the maximum number of ponds in a 'Priority 3 category', which means that the area is not the best sites for ponds due to its geology. Yet there are pockets of perenniality, which need to be optimised to meet the needs of the people and to plan for those who live in isolated or more difficult regions.

Chitra Khanna works as Project Coordinator, Towards Action And Learning (TAAL), Madhya Pradesh, India.
E-mail: chitra@taalindia.org

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